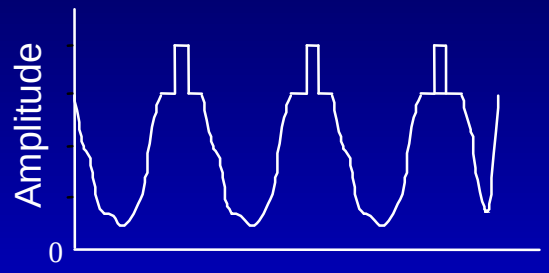
Analog television

- Introduction
- Analog TV systems
- Progressive and interlaced systems
- Synchronism signals
- Composite signal
- Components signal
- NTSC and PAL systems
- Sampling of the TV signal

Basic TV system

Real world

Camera



Electrical signal

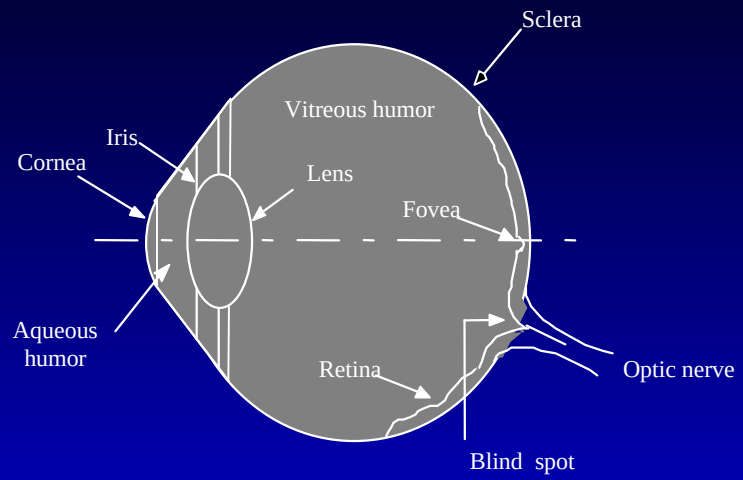
Transmitter

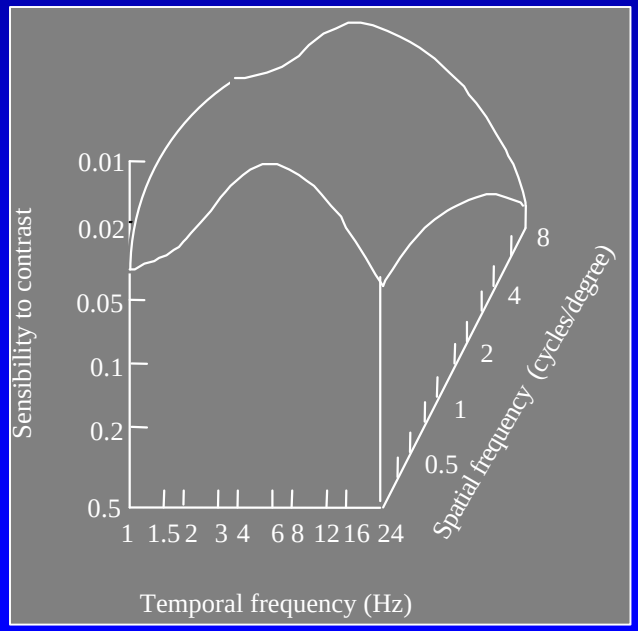
Receiver

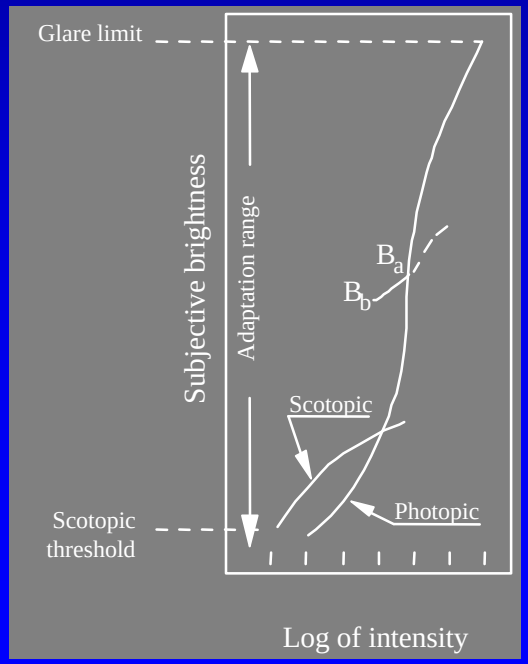
TV screen

Visual system

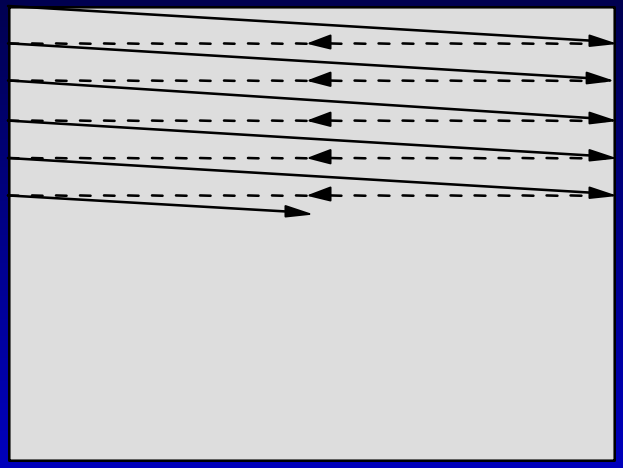
Human visual system







Progressive TV system



Number of lines per image:

Depends on desired vertical definition

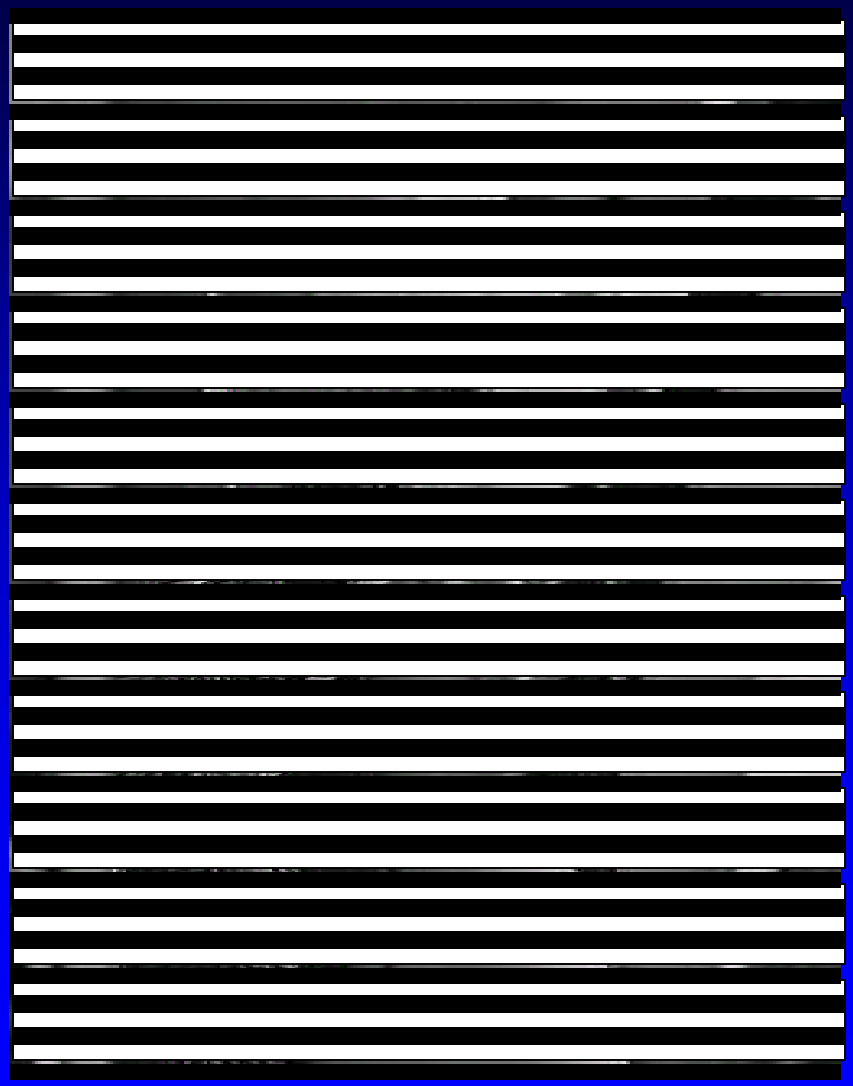
Number of images per second:

No flicker > 50
Motion sensation > 15

Vertical definition (1)

1 cycle

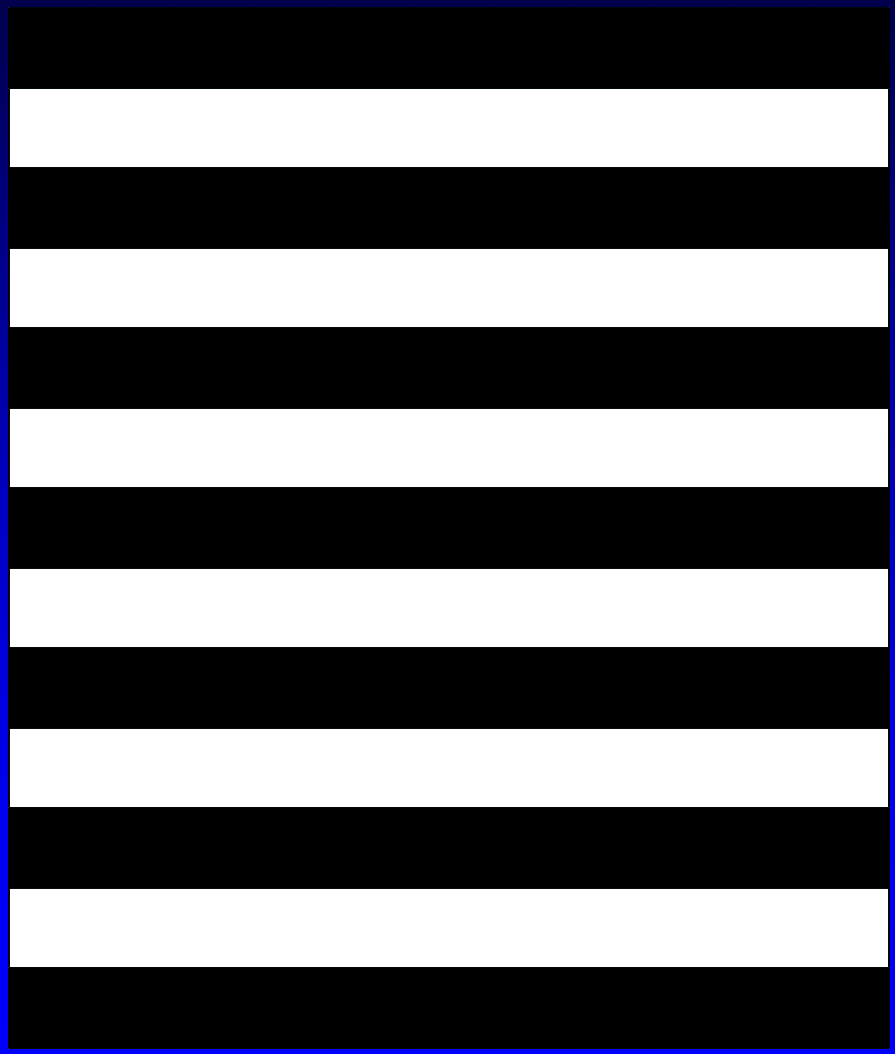
33.5 cycles
per image height



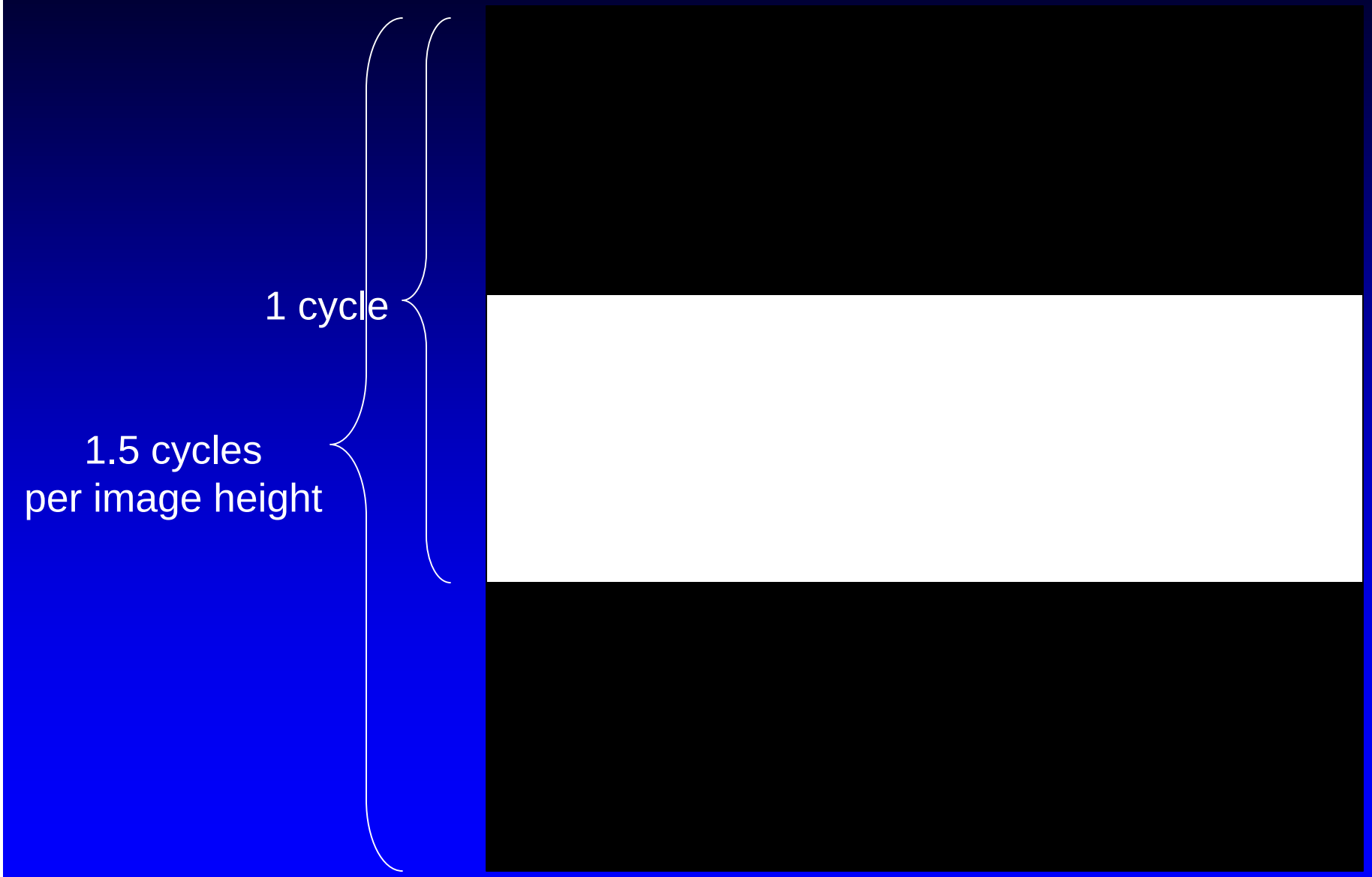
Vertical definition (2)

1 cycle

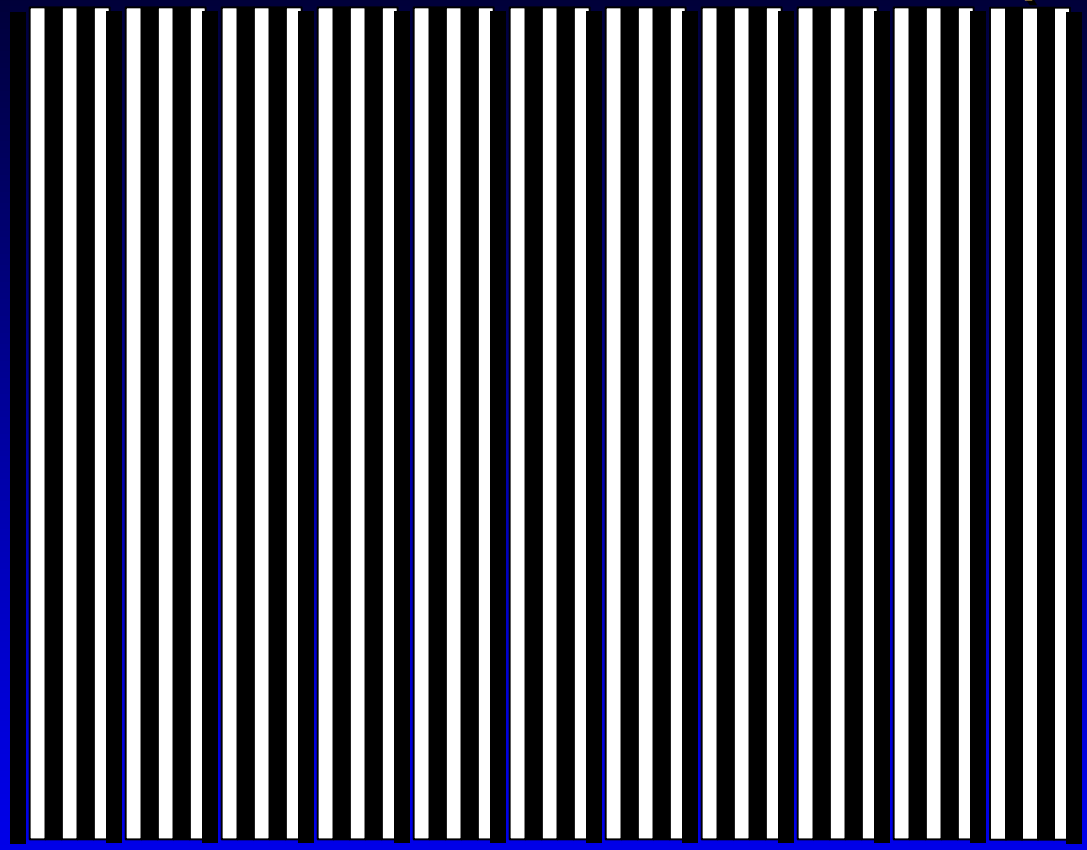
6.5 cycles
per image height



Vertical definition (3)



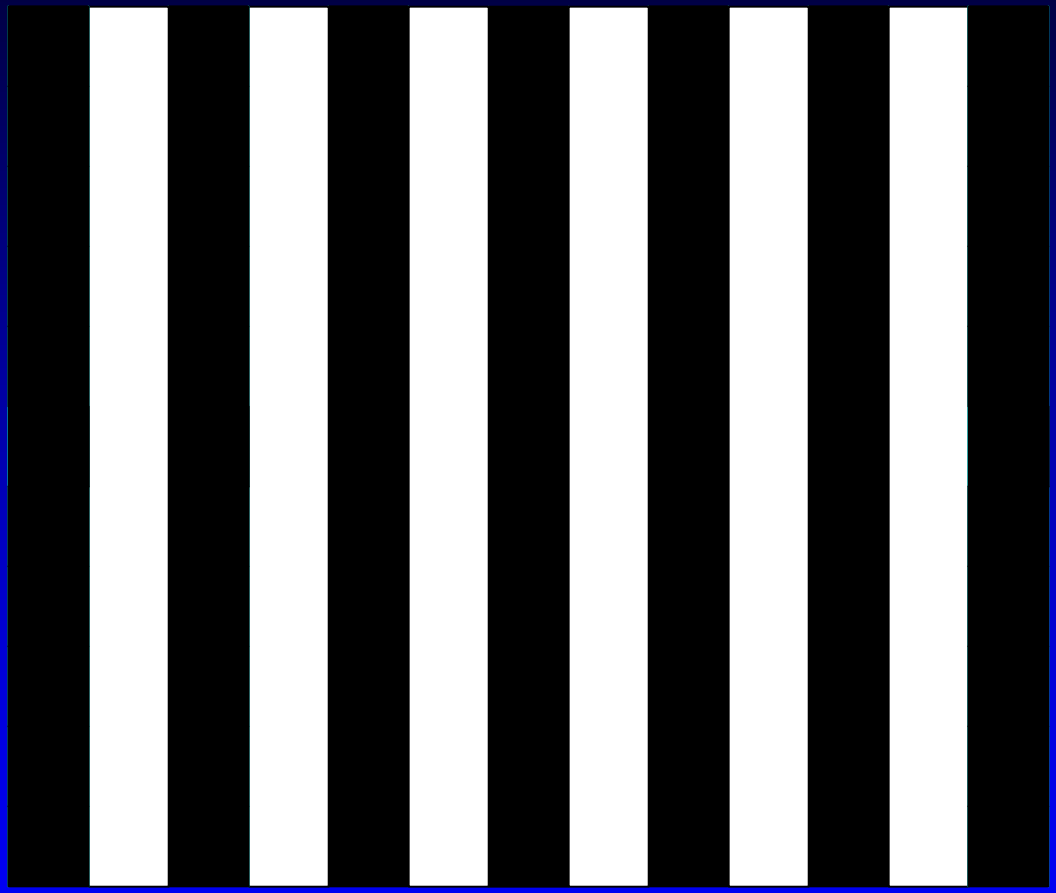
Horizontal definition (1)



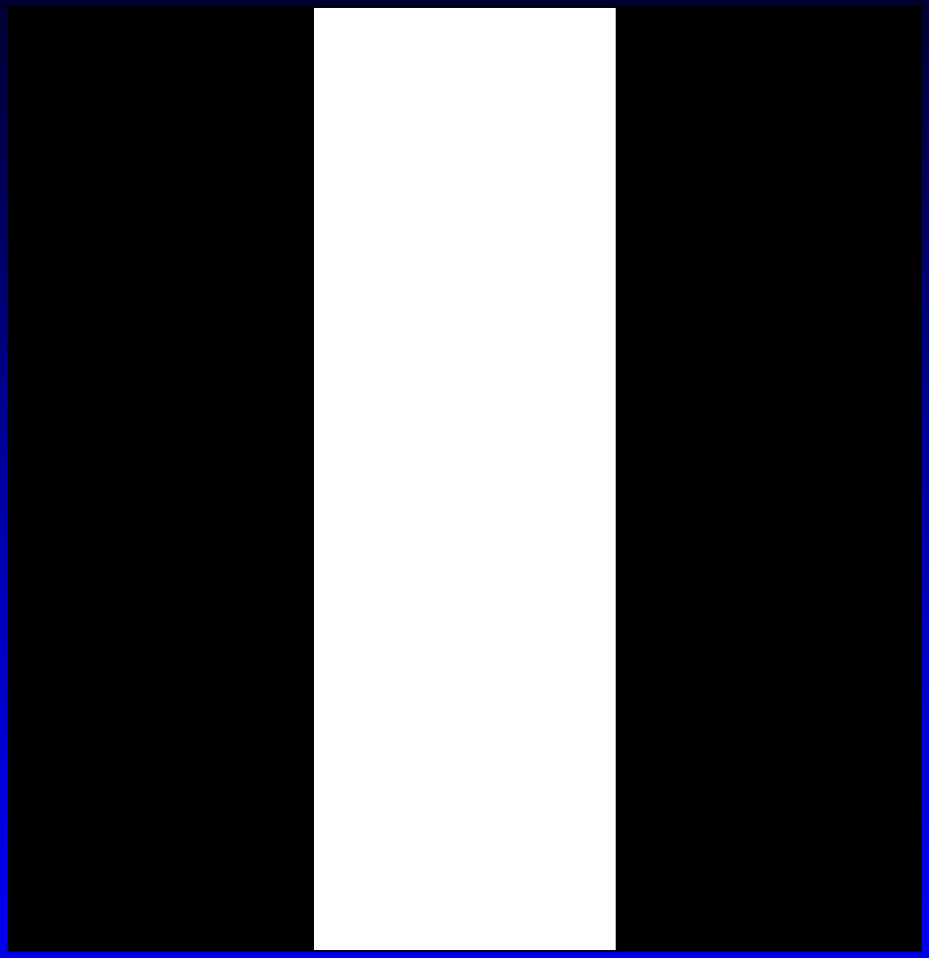
1 cycle

33.5 cycles
per image width

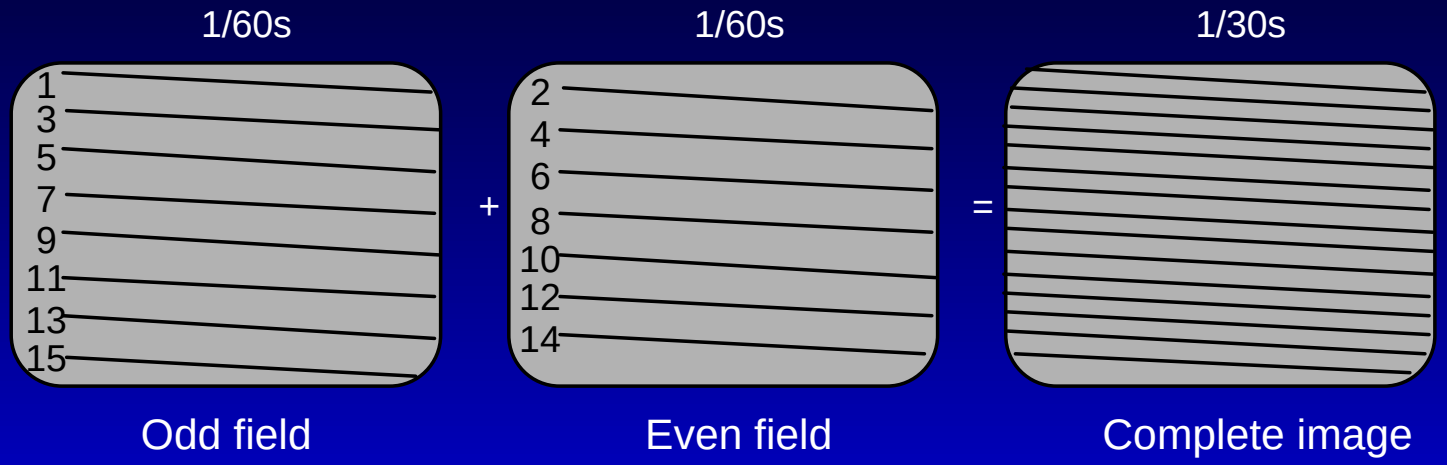
Horizontal definition (2)

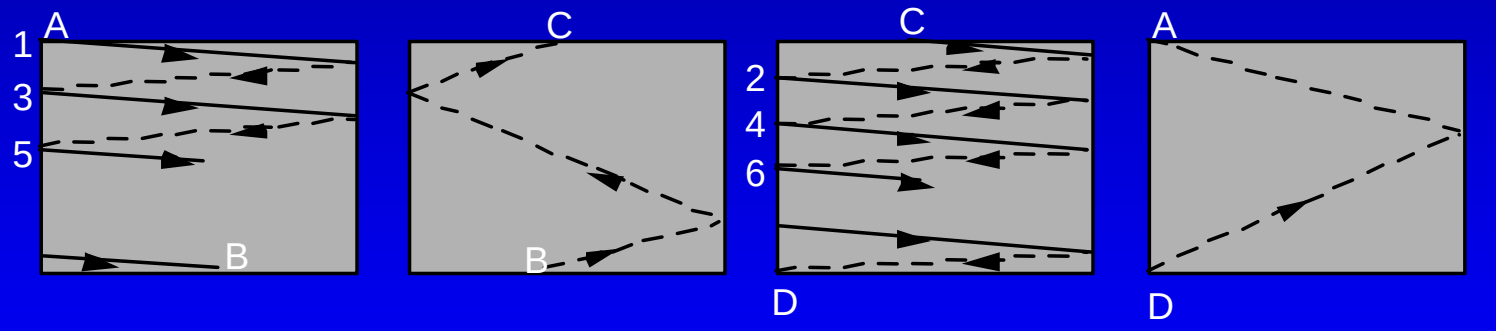


Horizontal definition (3)



Interlaced TV system (1)

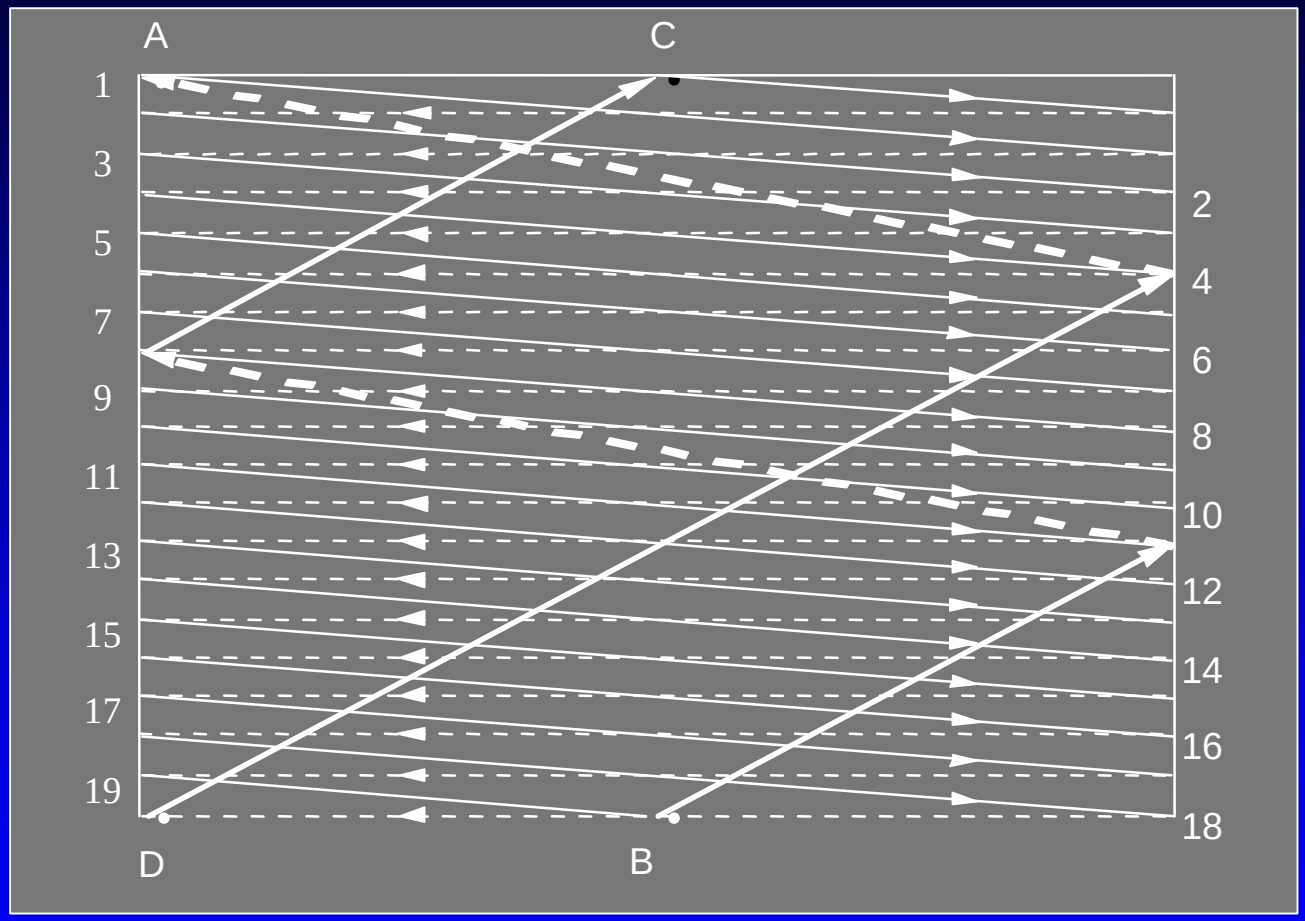




Number of lines: 525
Number of images: 30

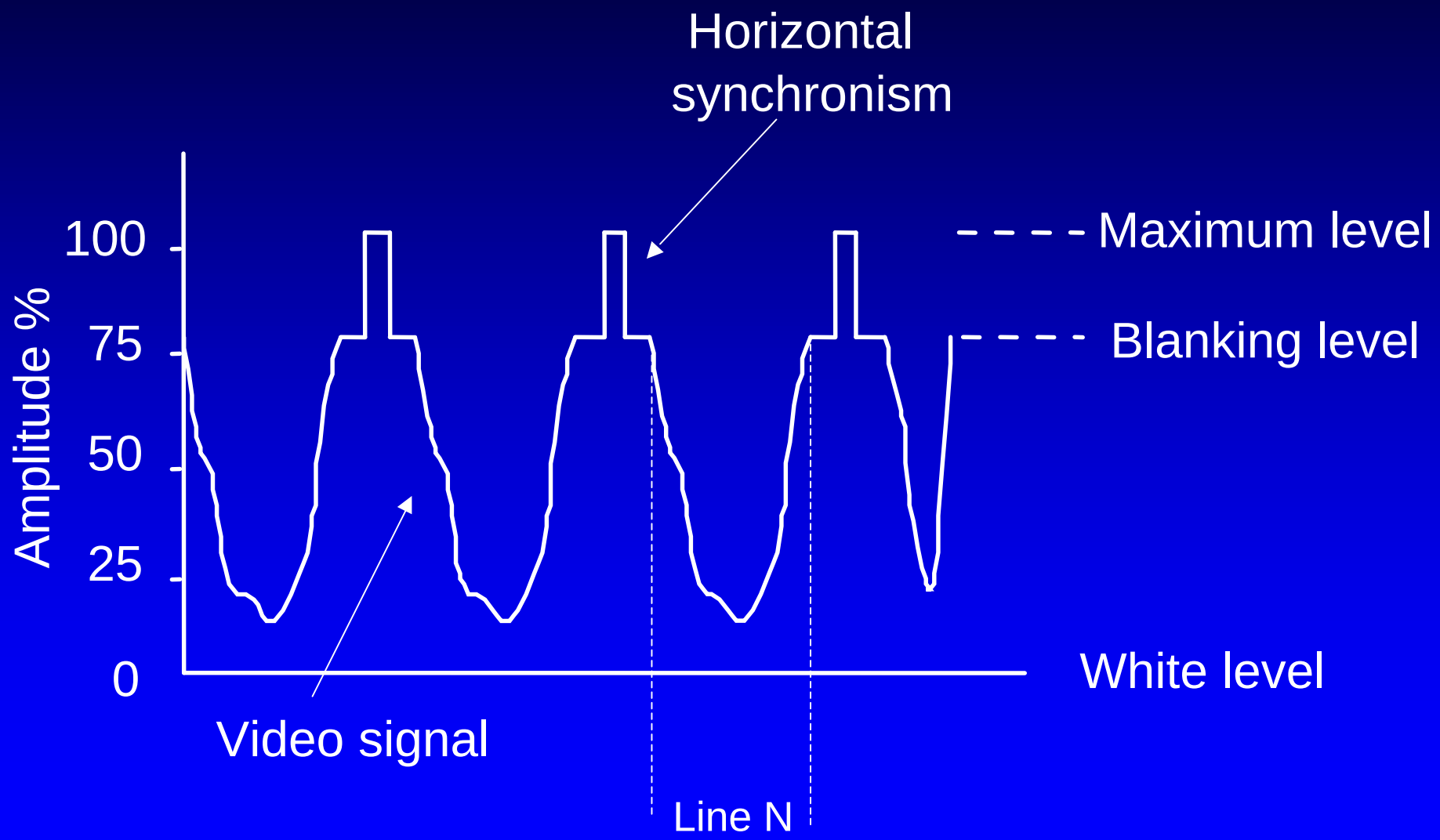
Number of fields: 60
2 fields = 1 image

Interlaced TV system (2)

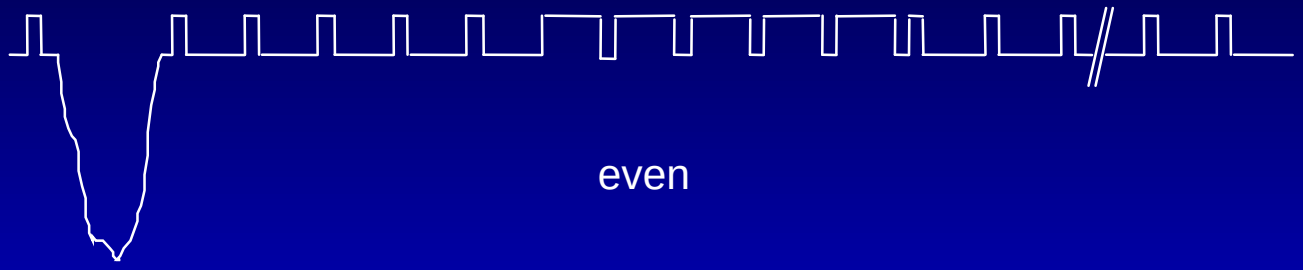


Horizontal scanning
Horizontal flyback
Vertical flyback

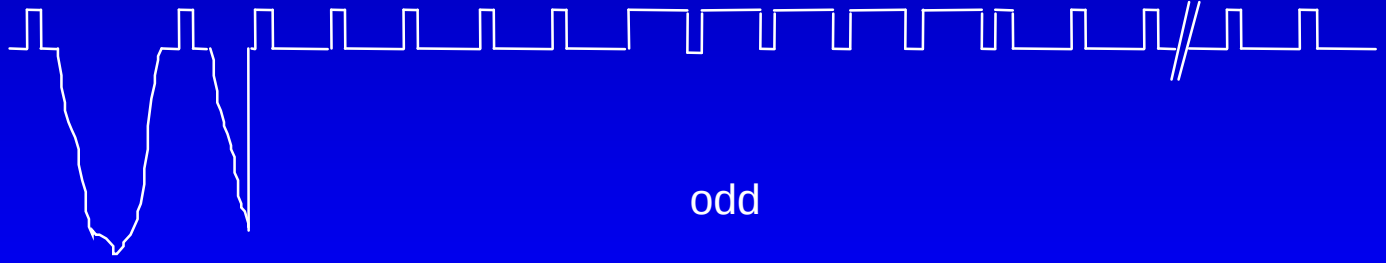
TV signal - B/W


Horizontal
synchronism
Amplitude %
100
75
50
25
0
Maximum level
Blanking level
White level
Video signal
Line N

Field synchronism



even

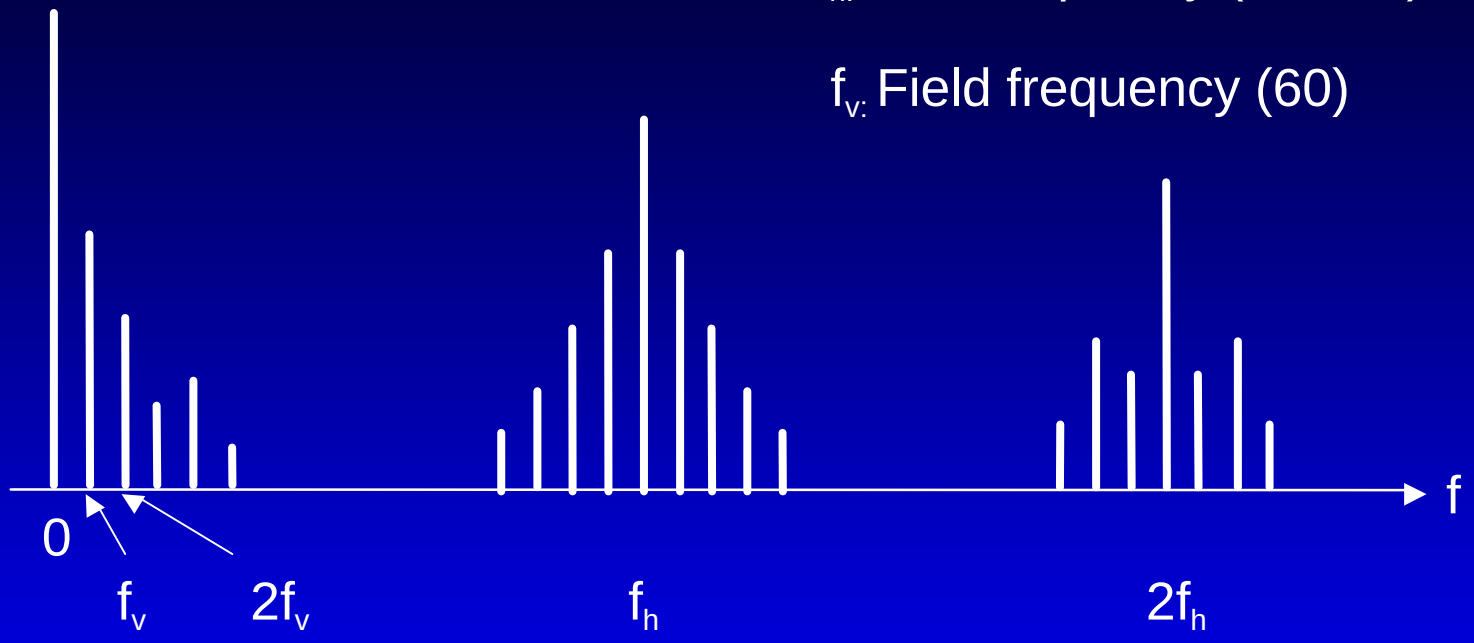


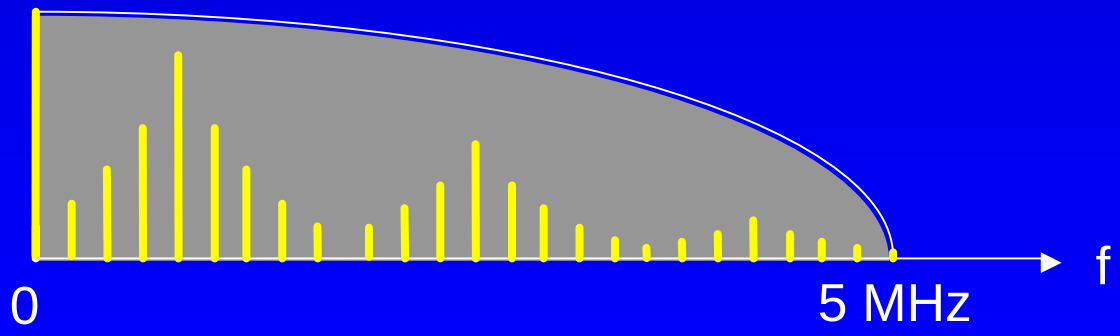
odd

TV signal spectrum - B/W

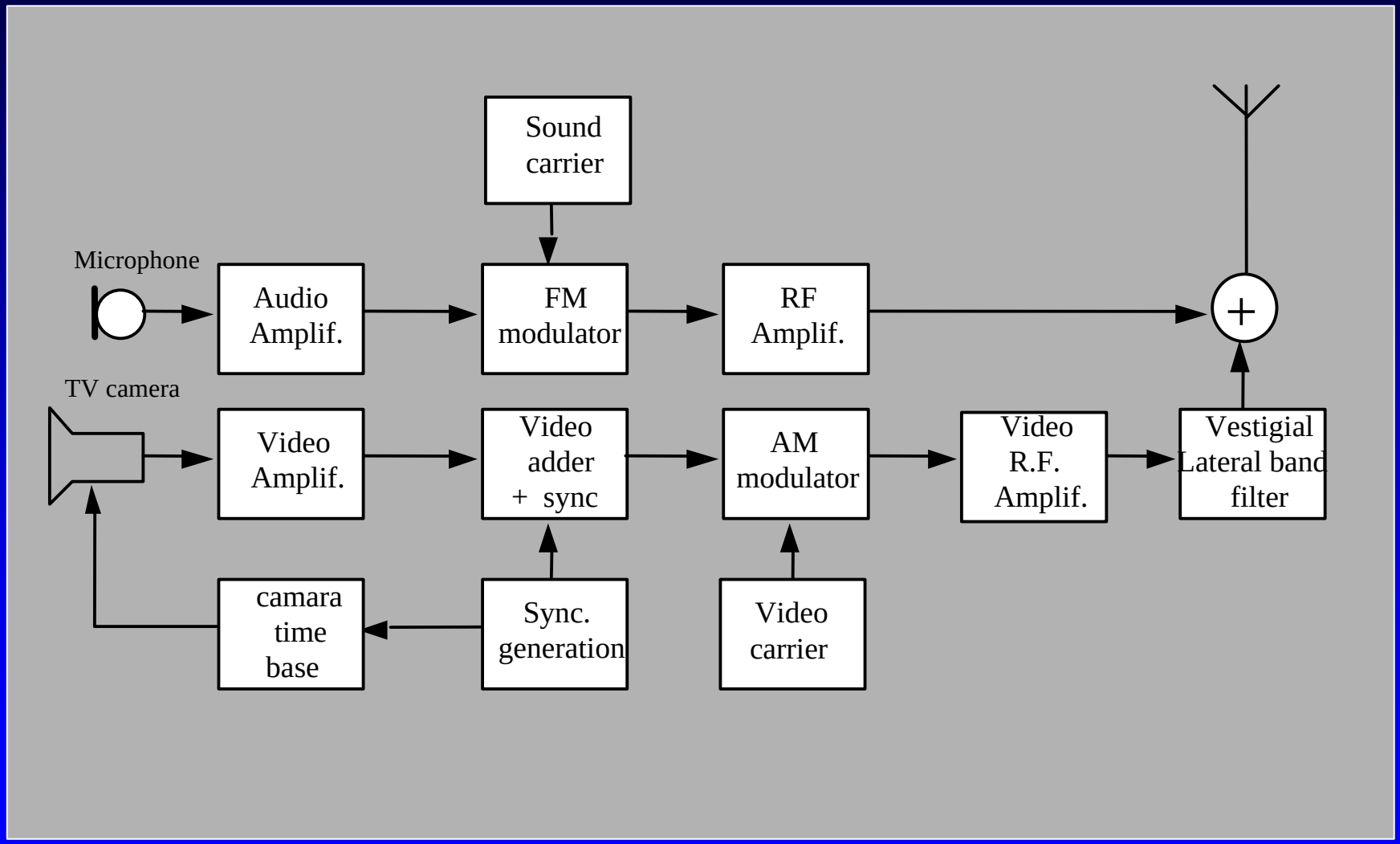
$f_{h:}$ Line frequency (15.750)

$f_{v:}$ Field frequency (60)

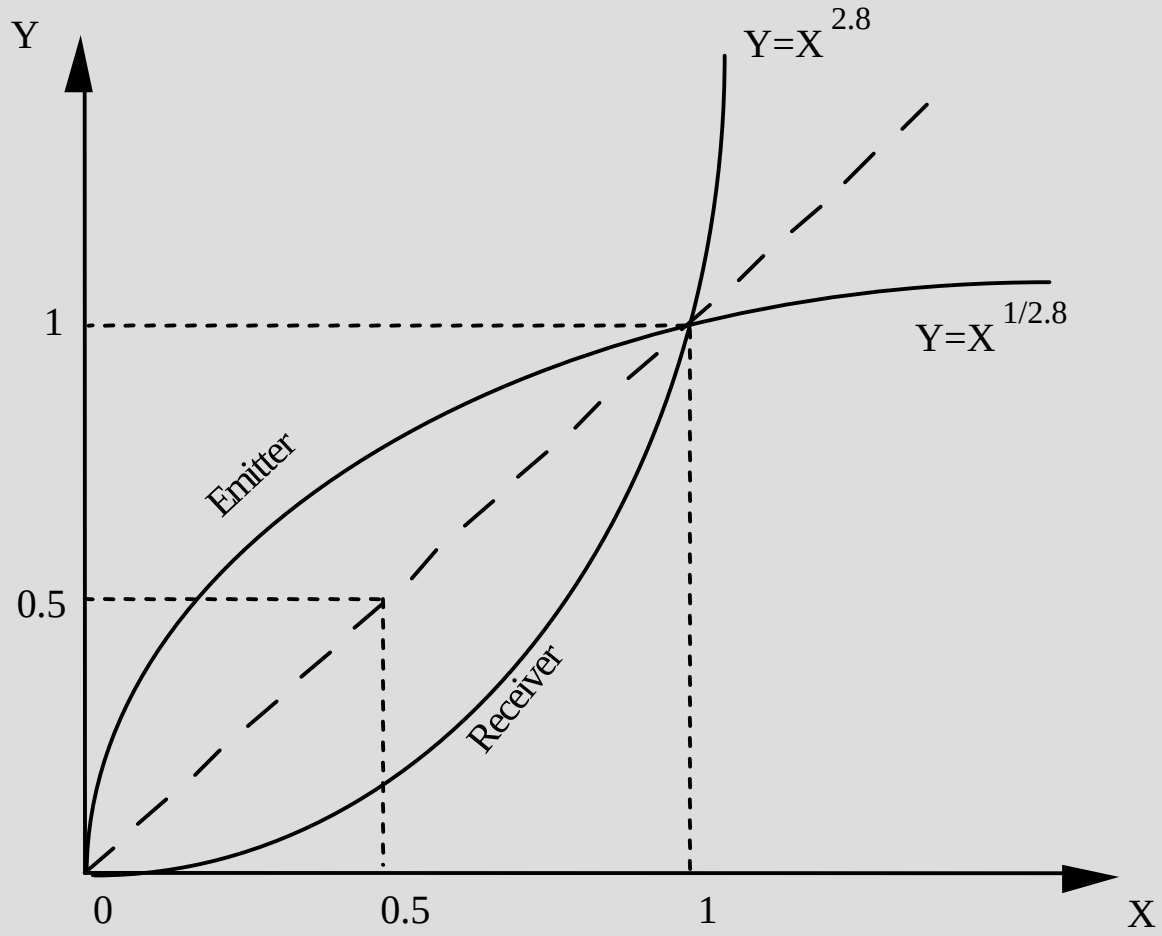




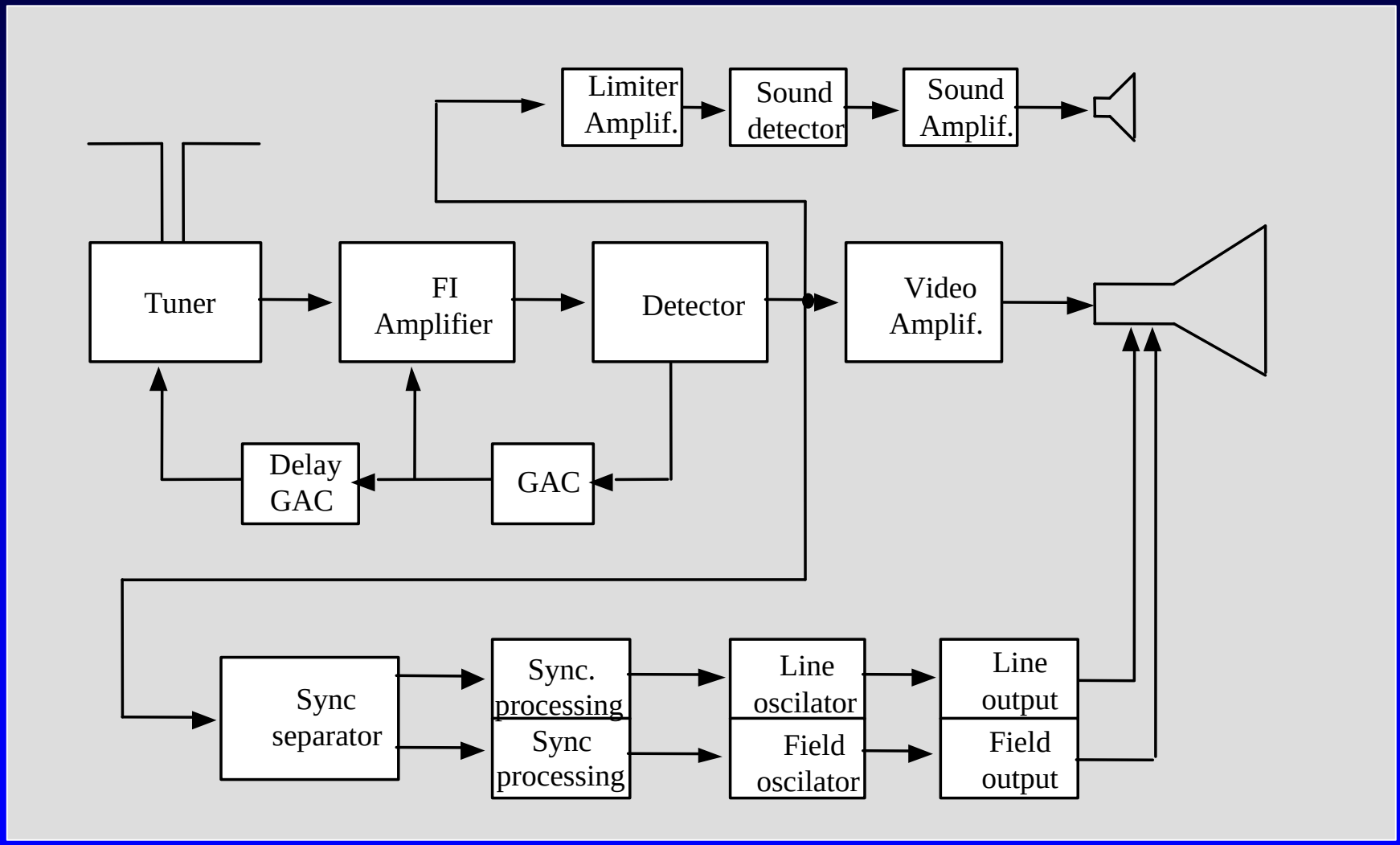
TV emitter - B/W



Gamma correction

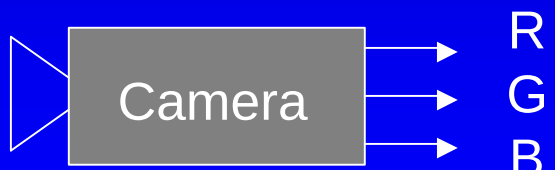


TV receiver - B/W



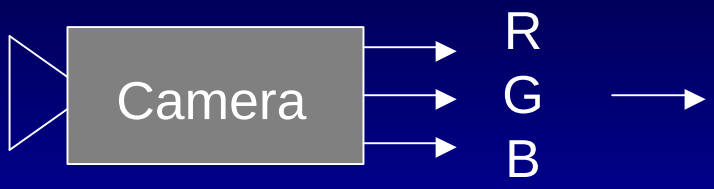
Color TV systems

+



Bandwidth is
3 x 5 MHz = 15 Mhz

Component TV color signals



Y = 0.30R + 0.59G + 0.11B — 5 MHz
u = 0.495 (B – Y) — 1 MHz
v = 0.877 (R - Y) — 1 Mhz

Bandwidth is 7 Mhz

Y - Luminance

u = 0.495 (B – Y)

v = 0.877 (R - Y)

TV color signals (1)

R
G
B

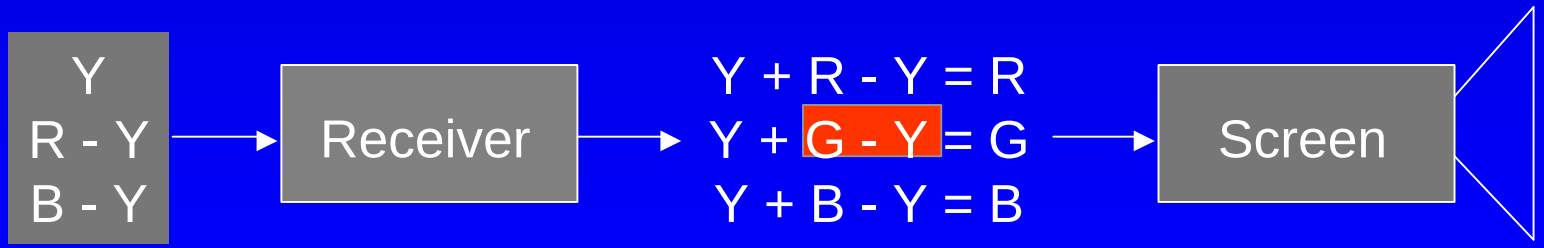
Y = 0.30R + 0.59G + 0.11B
R - Y
B - Y

5 MHz
1 MHz
1 Mhz

Bandwidth is 7 Mhz

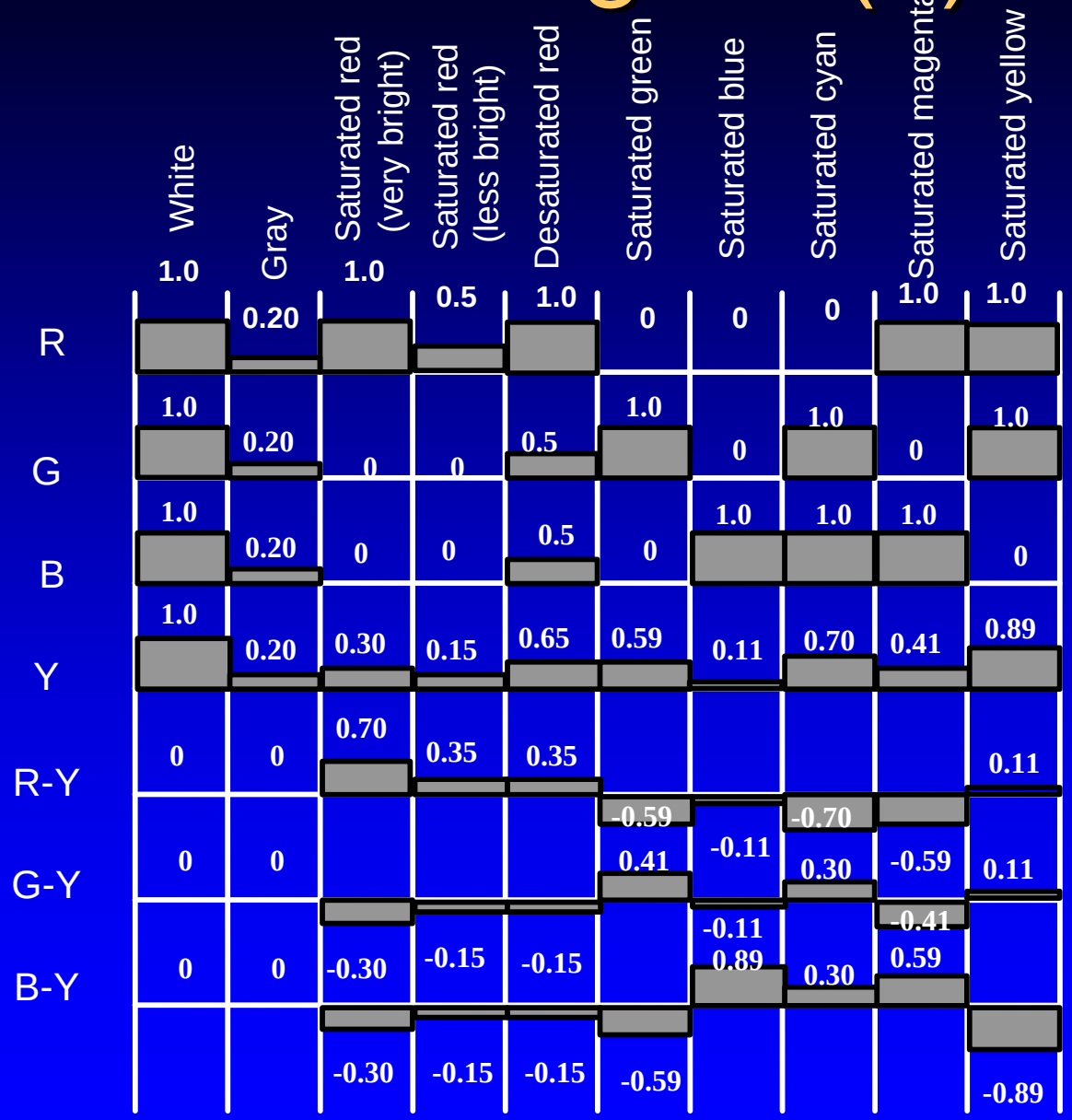
R-Y = R - (0.30R + 0.59G + 0.11B) = 0.7R - 0.59G - 0.11B

B-Y = B - (0.30R + 0.59G + 0.11B) = -0.3R - 0.59G + 0.89B



G - Y = -(0.3/0.59)(R - Y) - (0.11/0.59)(B - Y)

TV color signals(2)



NTSC signals

NTSC defines

$$I = 0.877\,(R - Y)\cos 33 - 0.493\,(B - Y)\sin 33$$

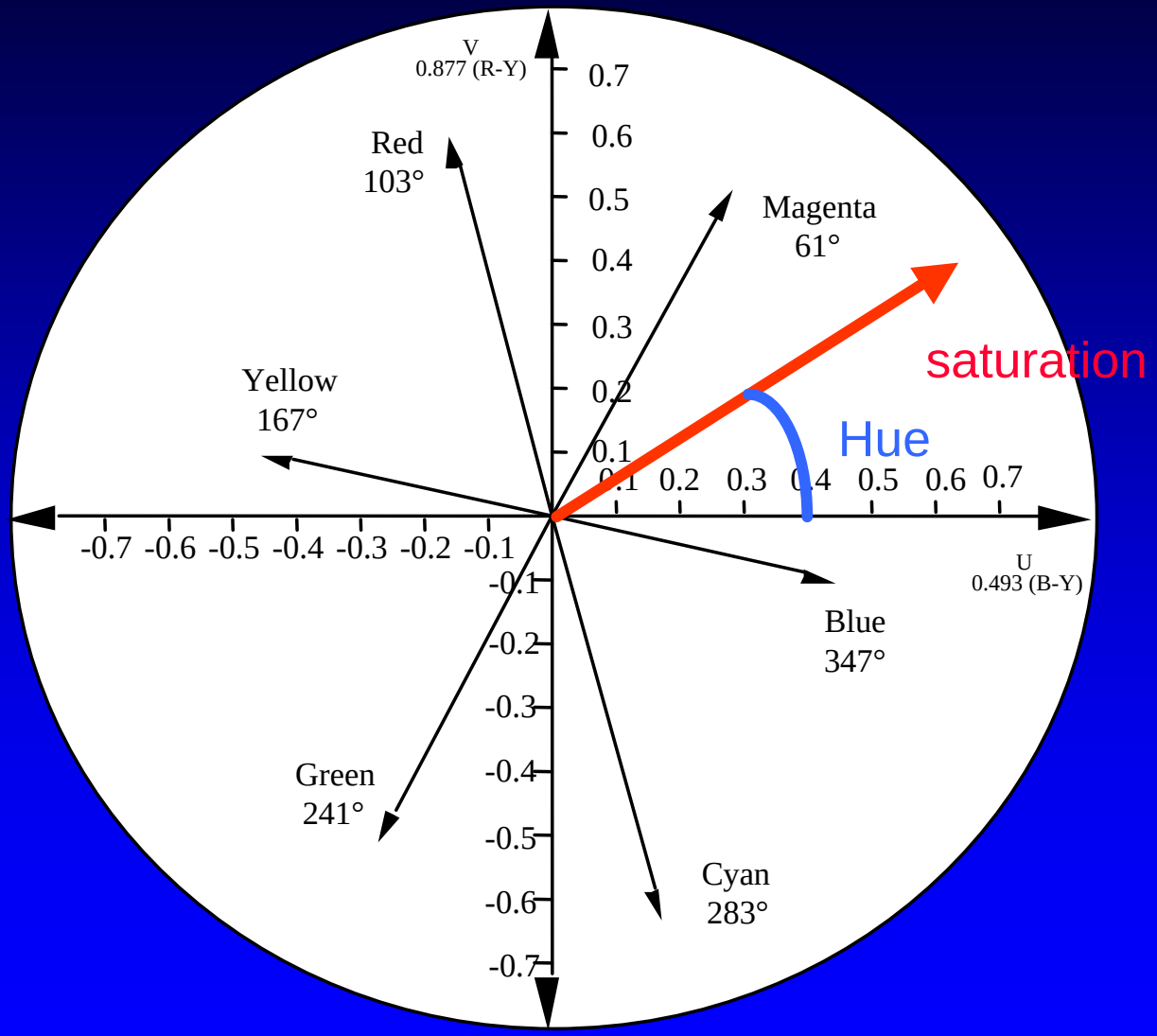
$$Q = 0.877\,(R - Y)\sin 33 + 0.493\,(B - Y)\cos 33$$

I Bandwidth: 1.5 Mhz

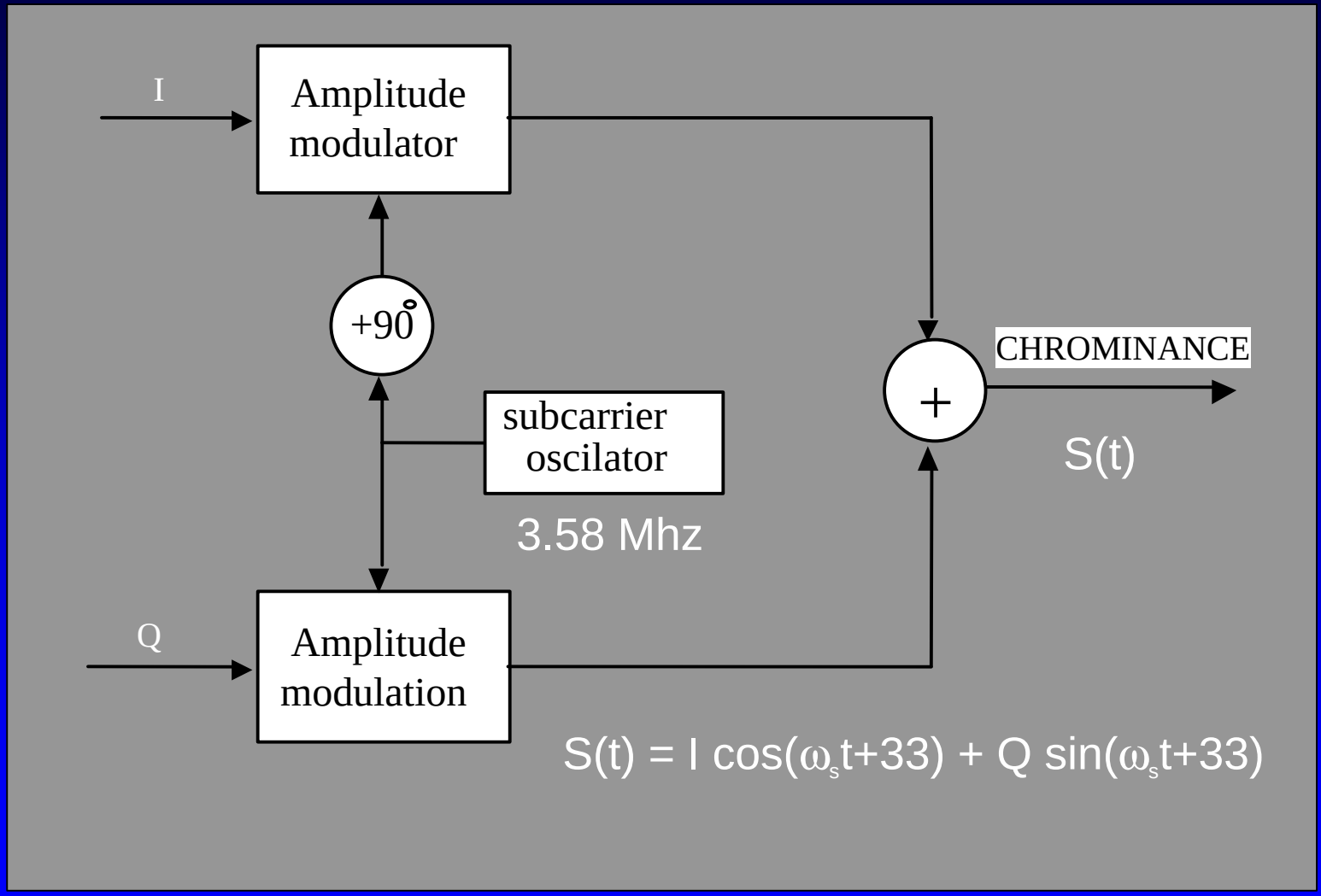
Q Bandwidth: 0.5 Mhz

Note: Next slides will use, (I,Q), (u,v) or (R-Y, B-Y) indistinctly
Signals are not *exactly* the same, but concepts are.
There is a weighting factor applied

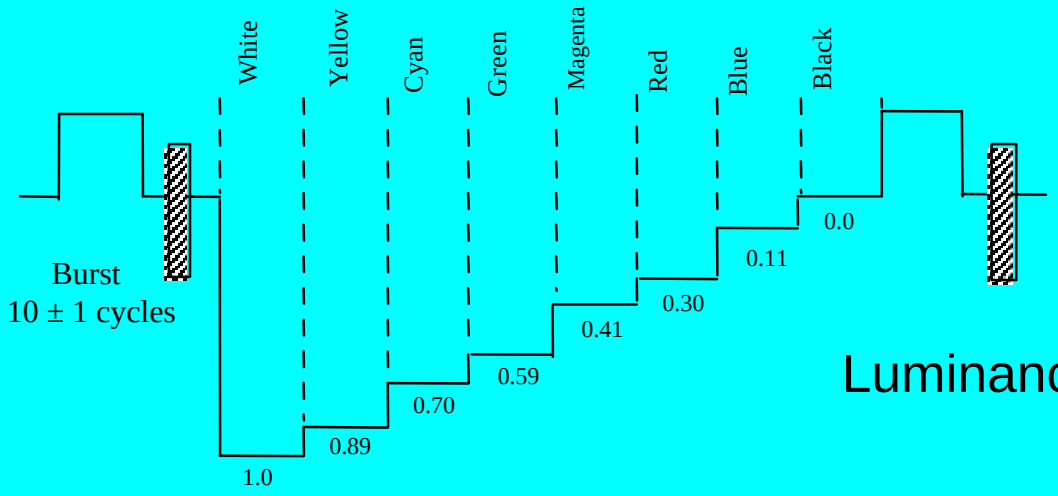
Colors and u-v signals



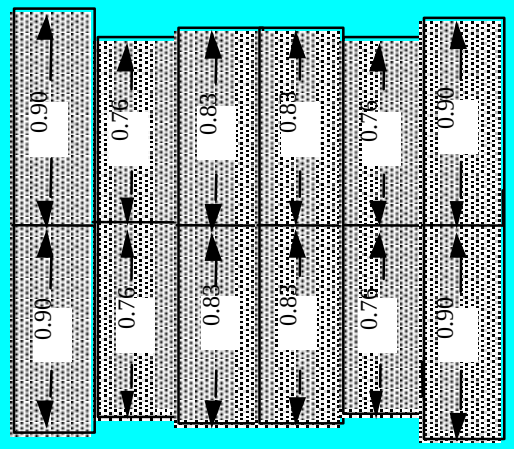
Transmission of color signals - NTSC



Chrominance signal

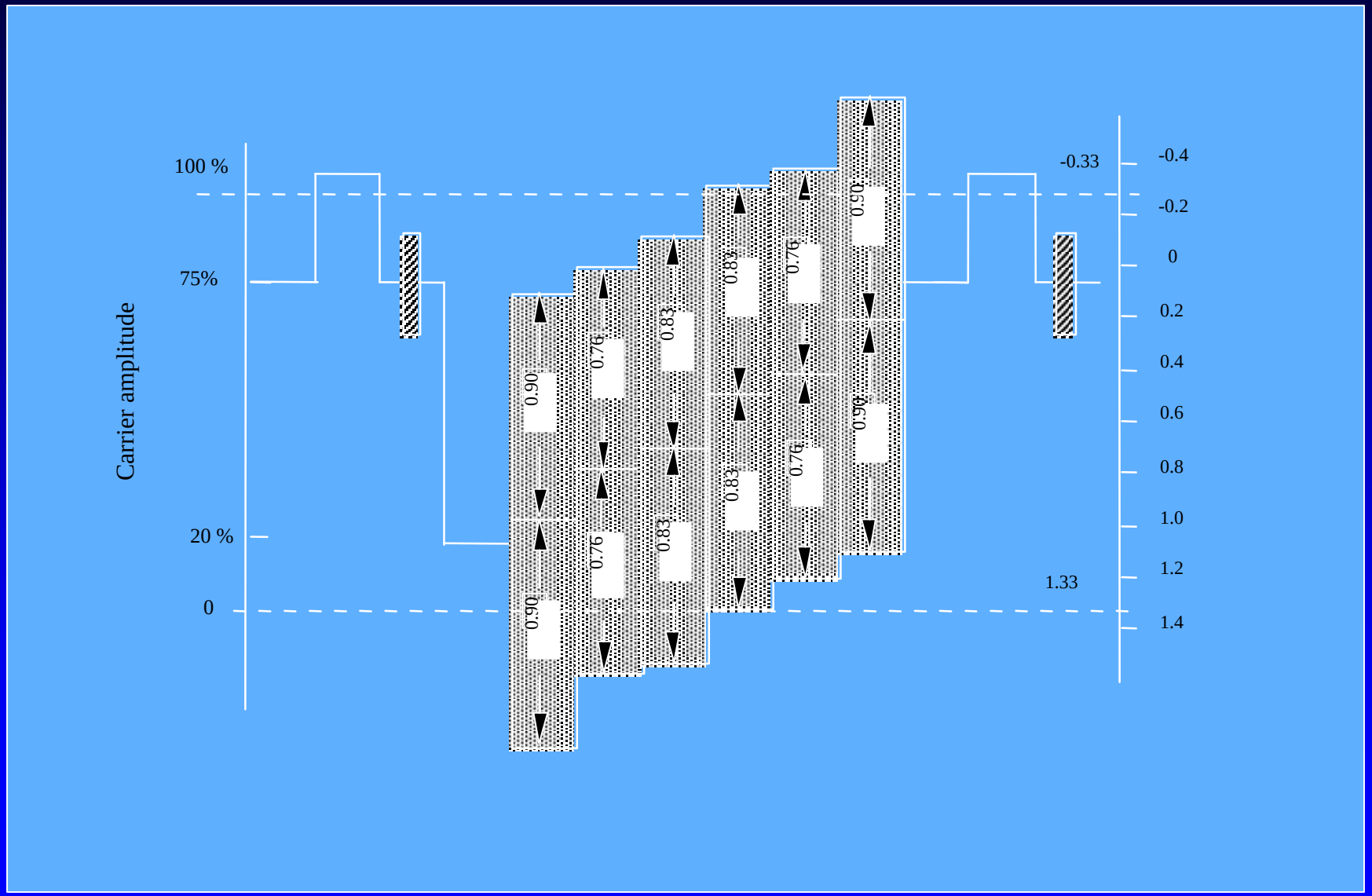


Luminance signal

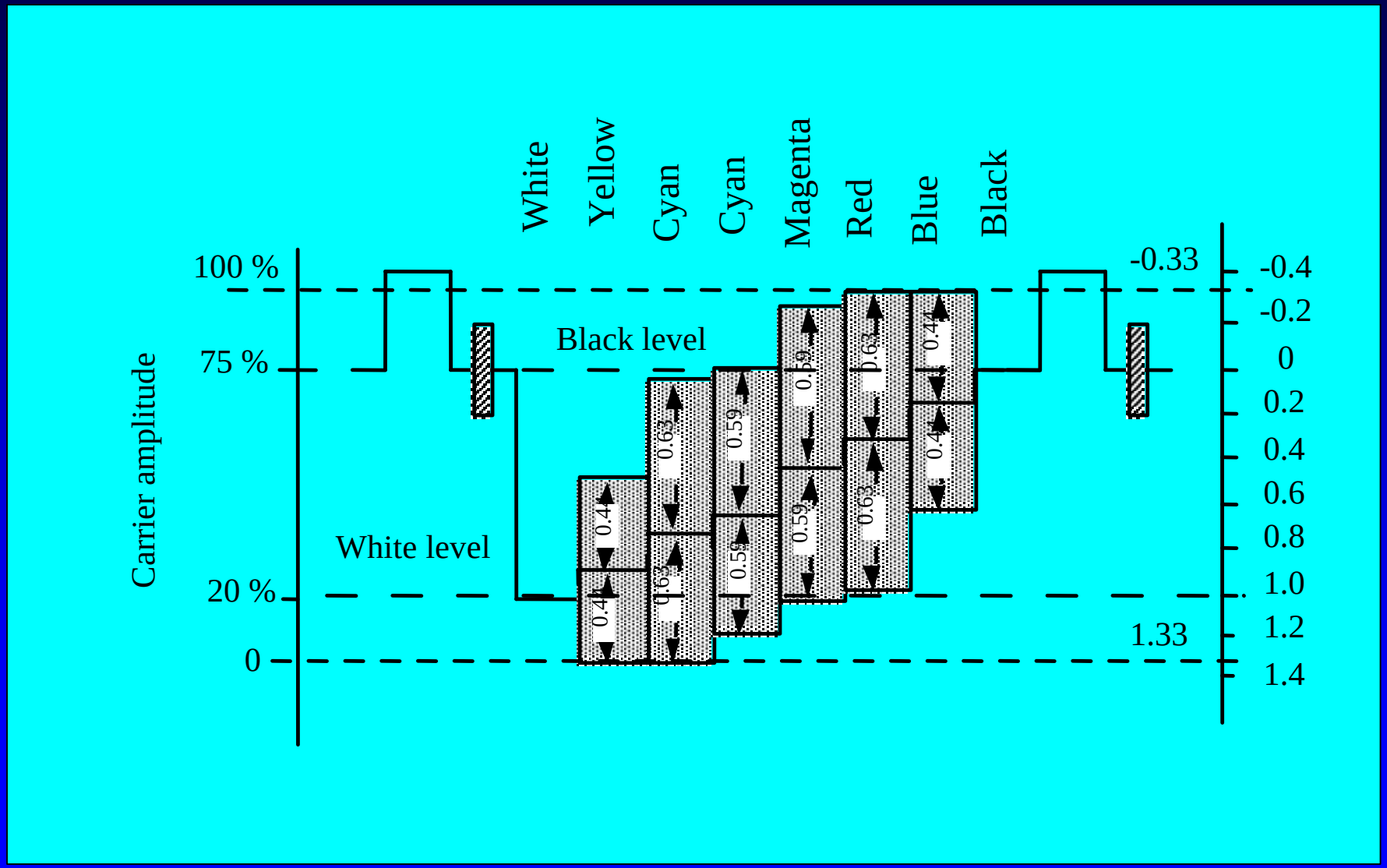


Chrominance signal

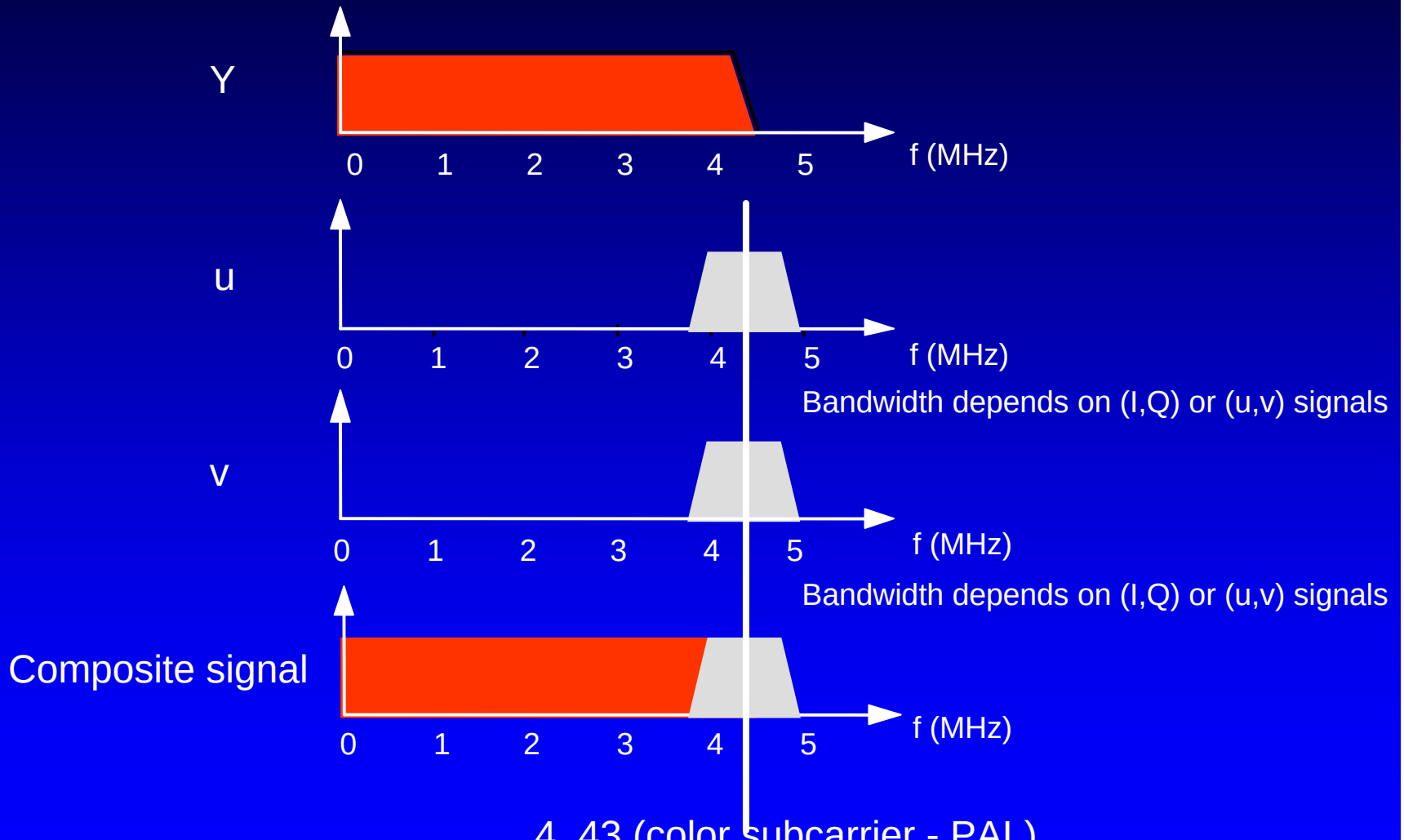
Composite video signal



Weighted composite video signal



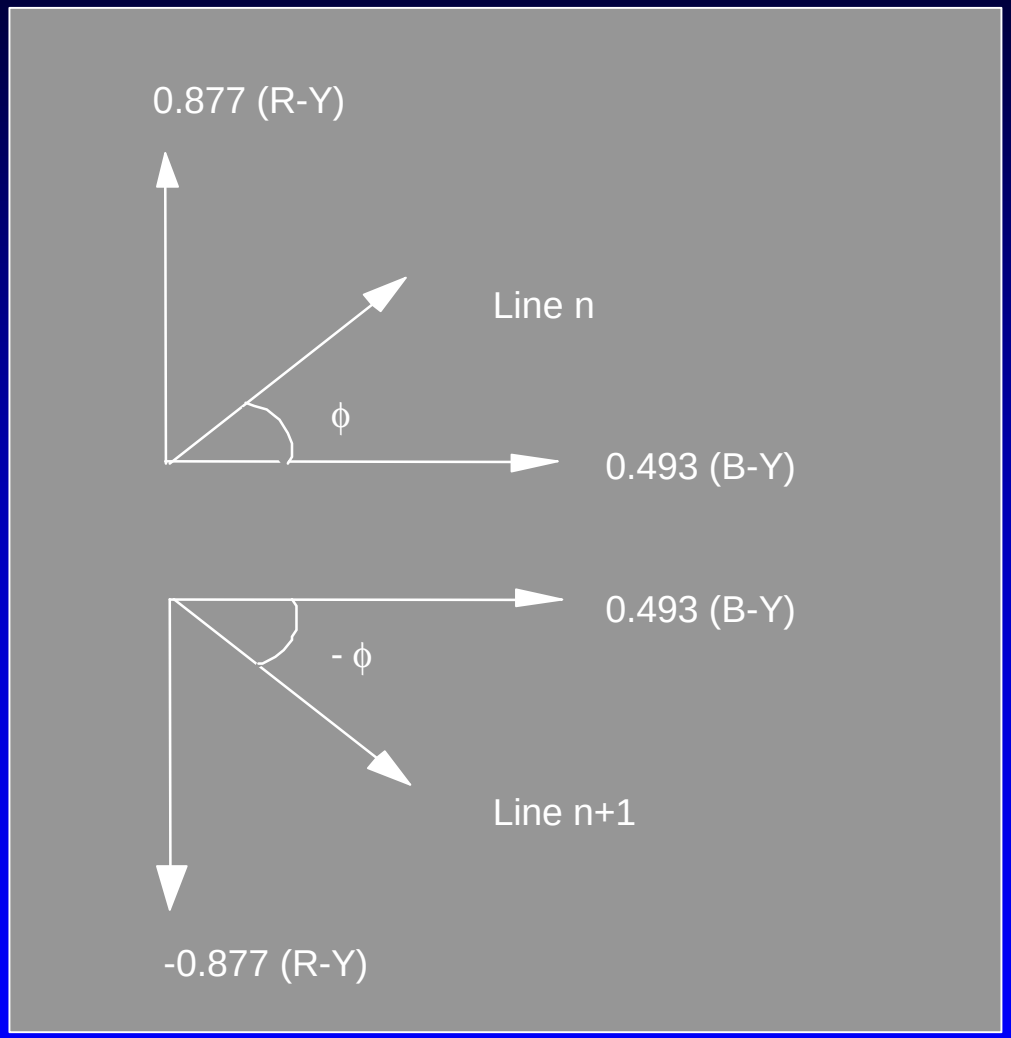
Composite video signal spectrum



4. 43 (color subcarrier - PAL)
3.58 (color subcarrier – NTSC)

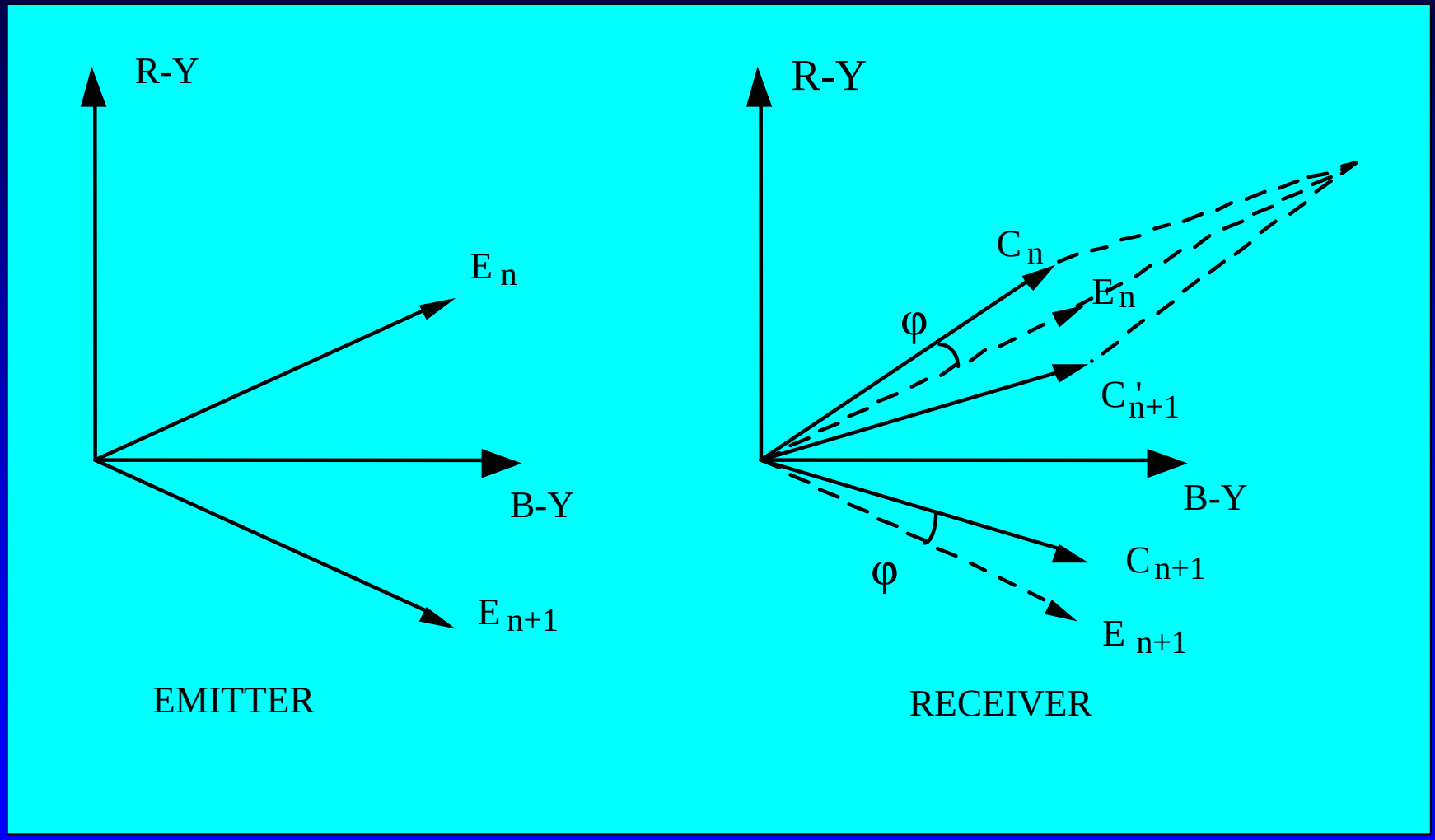
PAL system (1)

R – Y is switched each line to compensate for the phase errors (hue)



$$S(t) = (B\text{-}Y)\sin(\omega_s t) \pm (R\text{-}Y)\cos(\omega_s t)$$

PAL system (2)



Sampling of the TV signal

- Component sampling

  Applications: multimedia, Digital TV

- Composite signal sampling

  Applications at the TV receiver

  Image enhancement

  Flicker reduction

Component sampling

	ITU - 601	CIF	QCIF
Sampled signals	Y, u, v	Y, u, v	Y, u, v
Sampling frequency Mhz.	(Y) 13.5 - (u,v) 6.75	(Y) 6.75 - (u,v) 3.375	(Y) 6.75 - (u,v) 3.375
Sampling structure	orthogonal 1:1	orthogonal 1:1	orthogonal 1:1
Pixels / image	(Y): 720 x 576	(Y): 352 x 288	(Y): 176 x 144
	(u,v): 360 x 288	(u,v): 176 x 144	(u,v): 88 x 72
Bits/pixel	8	8	8